

it not agreeing, as they all died in the course of a few days. Other species feeding on the leaves of the same branch were thriving exceedingly. A few of these confined specimens began to bring forth young aphids of the third generation, which showed even more activity than either of the two previous generations, wandering about very restlessly without even attempting to feed; they all perished in a short time. The food plant of the second generation after acquiring wings and of their immediate issue, is, therefore, not the poplar but some other plant. The active habits, long beak and other characteristics of the third generation would indicate that they feed on harder parts of a plant, as the bark or twigs, not excluding the roots.

A short summary of the life-history would, therefore, give us the following stages :

1. Egg hatches about the middle of May.
2. The stem-mother starts the gall in which she passes through four months in the course of about two weeks; begins to bring forth the second generation about the first of June, and continues through the month, after which she dies without leaving the gall.
3. The second generation also passes through the customary months in the gall; all acquire wings and leave the gall about the middle of July, when they migrate to some other plant, yet unknown.
4. The following generations are now continued under different conditions, until in fall, when the true sexes are produced, which couple, and the females return to the poplars to deposit the fecundated eggs.

In places where this species should become so numerous as to need some check, the best remedy would evidently be to pluck the galls and destroy them during the month of June, before the second generation has taken to flight. The galls are almost all confined to young trees of six to fifteen feet in height, so there is no great difficulty in reaching them. Picking the galls after the middle of July is, of course, of no use, unless to remove them as unsightly objects.

President Elliot. We have another paper in this direction by Prof. Luggar.

INSECTS INJURIOUS TO SMALL FRUIT.

By Prof. Otto Luggar, Ph. D.

Ladies and Gentlemen:

Before entering into a discussion about some insects injurious to currants, blackberries and raspberries, which are, perhaps, all well known to you, permit me to make some general remarks as to how noxious insects multiply, and the methods employed by nature to check any undue increase.

We all know that all insects undergo a number of metamorphoses before reaching the age of sexual maturity. These metamorphoses are more or less abrupt, though the differences between

the various stages are usually very well marked. The first stage, that of an egg, is common to all animated beings, be they animals or plants, and consequently every insect hatches from an egg. A sudden increase of insects is therefore not due to any mysterious or unexplainable phenomenon as some ignorant people are still inclined to believe, but to the previous greater abundance of females. These females prove by their very numbers that atmospheric and other conditions were very favorable to their well-being, and that they had an abundance of food. Being in such a healthy condition they deposit a very large number of eggs, which in due time give forth the young larvæ, caterpillars, maggots, worms, or by whatever name they may be designated. If one acre with any kind of plants harbors only one hundred female insects, but very few persons will ever notice their presence at all. But let each female deposit only 500 eggs, by no means an exaggerated average number, and all of a sudden 50,000 hungry caterpillars or worms appear upon the scene. What remains of the vegetation upon that doomed acre is not a paying harvest, and even the worst observer, if not entirely blind, will now notice that this field is teeming with life, and he will very likely wonder whence came this multitude. *Suitable climatic conditions and plenty of food are the causes of the rapid increase of all insects.*

The former are not under our control, as the sun will shine with equal force upon saint and sinner. But we can control to a great extent the amount of food which we grow for our insect foes. The modern tendency is to grow as much as possible only one kind of crop, because it is easier and moreover cheaper. But every farmer and horticulturist in doing so, does his very best to induce the undue multiplication of such insects that are fond of that very same kind of plant; he spreads the table with the most inviting and improved morsels, and says to his enemies: "Come help yourself." Of course the whole thing is somewhat akin to gambling, because the farmer risks everything upon one card, and if this wins, he is all right, at least so in his own opinion. But very frequently he is wrong, as the many exhausted and deeply mortgaged southern, western, and eastern farms tell us too plainly. But, at least as far as farming proper is concerned, do such things take place only away from home? Diversified farming would, perhaps, increase the number of noxious species of insects in any give locality, but it would not permit any one species to become too numerous to be successfully combatted.

The introduction of noxious insects from foreign countries into new regions also occurs from time to time, but is only likely to take place at or near our Atlantic and Pacific coasts. Such introduced insects, if suited to our climate, usually spread very rapidly and almost without hindrance, for the simple reason that their insect enemies have not been brought over at the same time. It frequently takes a number of years before our friends amongst the native insects take hold of the newcomers, and not until then is their further spread and increase more or less checked.

NATURAL METHODS TO CHECK NOXIOUS INSECTS.

We have to consider two well established natural laws, which counteract each other and struggle for supremacy. This struggle is so bitter that neither pardon is asked nor given. Nature seems cruel, but she is forced to be so by inflexible laws, and as the result are solely for the benefit and advancement of all the members composing the animal and vegetable kingdoms, we can only admire these methods. The two conflicting laws are: "Be fruitful and multiply," and "Struggle for life?" If the former law had full sway, pandemonium would soon reign supreme. The second natural law acts as a wholesome check upon it, keeps any unlimited increase of specimens in due bounds, so that only the fittest animals and plants can survive and reproduce. Suppose a single female oyster could multiply without any natural check; a very few years would suffice to fill up the Atlantic ocean with oysters. If a single female herring should reach the mature age of ten years, her offsprings during that time would not alone increase beyond any computation, and would not alone fill up all the oceans, lakes, rivers and creeks, but would bodily crowd her to the top of mountains. What would become of the stately oak if all the acorns produced by it should grow into trees? They would furnish enough wood to build a dozen Chinese walls around the globe, high enough to hide the highest mountain tops. But as it is, the law: "Struggle for life" quietly steps in and allows only the strongest and best adopted offspring to continue the species. The "Survival of the fittest" is the necessary and all important consequence.

As soon as any noxious insect becomes unduly numerous, its enemies will increase as well, and most frequently at a much quicker rate. This is easy to explain, because instead of the previous scarcity of food that now abounds, and the parasitic insects, well fed, are now not required by necessity to search carefully and for a long time for their prey, and for the food for their offsprings. They find such food in abundance in their close proximity. Thus at last the moment arrives when the plant feeding and parasitic insects are nearly equally numerous. Now the parasites soon consume their hosts, and but few of them escape this general slaughter. But as soon as this happy condition of affairs takes place (happy at least for the fruit-grower), the parasitic insects in their turn have to suffer and die simply because there is no longer food for them and for all their offsprings. The few escaping lucky insects, both of the host and the parasite, gradually and slowly increase again in numbers. There is truly an "up and down" in the life-history of every insect.

For the horticulturist it is very important to know the differences between his friends and his enemies. But it is not a very easy matter for him to acquire this knowledge as there are immense numbers of different kinds of insects around him, which either belong to his friends and enemies or to indifferent insects—insects which, as far as he is concerned, are of no special importance to him.

Our best friends among parasitic insects occur in the orders: Wasps and Flies (Hymenoptera and Diptera). Those of the former are often called Ichneumon-flies, being compared with the well-known animal of that name, which is said to enter the throats of crocodiles to devour its eggs. Of course it requires a very strong constitution to swallow the story, antique as it is. *Ichneumonidae* among insects are very small wasps, usually of a bright and metallic color, which deposit their eggs in other living insects, but usually in the caterpillars, although the other stages of insects are by no means free of their attacks. These eggs hatch in time, and the maggots thrive inside their hosts, eating at first the fatty substances, later the vital organs as well. At least so the books tell us; but in fact they simply eat the softer parts first, simply because they are not as yet strong enough to devour the harder tissues until reaching maturity. When full-grown they either leave the dying host, or spin inside of it a tough silken cocoon, inside of which they transform to pupæ, and later to perfect insects, which leave their prison to enjoy life in less crowded quarters. Most of all insects known are infested with such parasites in the one or the other of their early stages. Even their eggs, small as they are, are large enough to give food and shelter to some *hymenopterous* insects of correspondingly small size.

Among the *Diptera* or Two-winged Flies we have also some very useful friends. Chief among them are the Tachina flies, which resemble our common house-flies, but are decidedly more useful. These parasites glue one or more eggs to their victims, usually caterpillars, from which footless maggots are soon hatched, which devour the whole interior of the host upon which they were born.

Of great assistance in this bloody war, a war of extermination, which is constantly going on in a silent way, at least to us huge bipeds, whose ears are not sensitive enough to hear the groans of the victims, birds, animals and reptiles, most, if not all our insectivorous birds and animals should be carefully protected; so our reptiles, providing they possess no poison. There is a great deal of superstition about many of the animals found in a wild state upon our fields and gardens; this superstition is mainly based upon the fables of a former and less enlightened age, and is but slowly disappearing under the knife of dissections made to prove beyond doubt upon what such animals subsist.

But the program of this evening calls for another paper: "Insects injurious to small fruit."

I have been unable to devote as much time to insects affecting small fruit as I would like, chiefly on account of having been away fighting grasshoppers in a region where horticulture is simply a name, not a fact. Still I always devote as much time to fruit of all kinds as I can, providing the fruit is ripe. Yet, what I have observed in Minnesota clearly shows that our horticulturists have their full share of noxious insects. I have gathered together in one small box, which is now before you, all the species of insects injurious to these plants that I have found thus far in our state. They are few in number if compared with those found in other

states, still there are enough to occupy much of the time of the fruit growers to fight and to get rid of. I have not made any attempt in this small collection to classify the specimens according to their food plants, as all of them occur upon plants of currants, blackberries or raspberries. Some of them prefer the one plant, others the other plant, but all are distinguished by being very injurious. By very injurious I do not mean to express that they are all always injurious. In most cases, when not numerous, they occasion but little damage, and this is easily overlooked. But this should not be the case! All of these insects, if favored by conditions which are beyond our control, can very soon become exceedingly numerous, and consequently injurious in proportion. So it behooves us to take time by the forelock, and to "remove them from office for cause or otherwise." An ounce of prevention is always better than a pound of cure. None of these insects should be allowed the freedom of our gardens and fields. Yet very few of you have ever seen the insects as displayed in the box, because in this their perfect or winged state they are either nocturnal in their habits or so small and nimble as to be readily overlooked. But you have no doubt seen them all in their earlier stages as caterpillars or slugs, or have seen their "trade-mark" upon leaves and stems. Every grower of the plants under consideration should make it a rule to visit them as often as possible, and he should never fail to hunt for caterpillars, to catch and dispatch them in any way he sees fit, providing it is a way that permits of no resurrection. No arsenical poisons should be used, if it is possible to get along without them. It so happens that most of the insects upon such plants that can be reached at all by poisons are double-brooded, and as the second generation is most frequently the injurious one, poison may later be used with advantage, as under the conditions then prevailing it will only be used after all the fruits have been gathered. But here lies one serious trouble: the plants without fruit have lost most of the interest they possessed earlier in the season; they are not inspected so often and so thoroughly as formerly, and thus many insects thrive and increase without hindrance, which—although not able to destroy the crop of that year—are only too apt to do so during the following season. Constant vigilance is the price of success, in fruit-growing as well as in any other business.

During the season of 1889 the following insects proved the most injurious ones, and specimens of their work were often received and found by me. The letters received with them plainly indicated that all these insects occur almost everywhere in the state where such plants are grown to any extent.

The Raspberry Flat-headed Borer (*Agilus ruficollis*).

The Snowy Tree-cricket (*Ecanthus niveus*).

The Imported Currant Stalk-borer (*Ageria tipuliformis*).

The American Currant Stalk-borer (*Psenocerus supernotatus*)

The Buffalo Tree-hopper (*Ceresa bubalus*).

In many cases the canes received showed the work of at least three different insects, all more or less injurious. But by all odds the most injurious one was the Raspberry Borer, or the Red-necked

Agrilus (*Agrilus ruficollis*.) (Fig. 1.) This insect is a beetle, and belongs to that large family of beetles whose larvæ are so well known by the name: "flat headed borers." Most horticulturists in more southern states know to their sorrow how injurious the flat-headed borers of the apple tree may become in certain years and in certain localities. Nor is this insect a great rarity in this state, where it occurs quite commonly in oaks. The

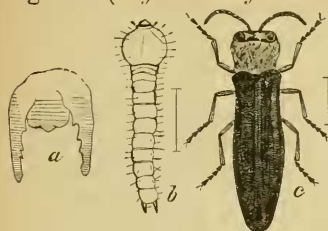


FIG. 1.

Red-necked *Agrilus* possesses the faculty of producing peculiar gall-like swellings upon the canes infested by it. (Fig. 2) These galls have received the name Raspberry Gouty Galls, from the fact that the stems swell up in particular places as if troubled by the gout yet this is not always the case, as I have frequently bred the insect



FIG. 2.

from canes that had been killed by them, yet showed no perceptible swellings. The illustration before you shows such a gall. The cane, instead of being smooth and of the same color as the healthy parts, is swollen, and is further distinguished by many short, rough, longitudinal slits. Numerous ridges may also be seen, which run round and round the axis of the cane. If, during autumn or spring, we cut into such ridges, and follow the burrow underneath, we find under each a little yellowish-white larva. This larva is distinguished from other larvæ occurring inside the cane, by having the body much flattened out horizontally. Its small head is retractile, and has brown jaws; a tail furnished with two long and slender dark brown thorns, as indicated in the illustration, is also quite characteristic. The size of this larva, if full grown, ranges from one-half to three-quarters of an inch. As the larvæ burrows exclusively in the sapwood, it frequently girdles the cane, thus killing it. Each gouty gall contains most frequently a number of such larvæ, and some of the canes investigated contained as many as seven. Towards fall the full-grown larva penetrates into the pit, where early in spring it transforms into a pupa.

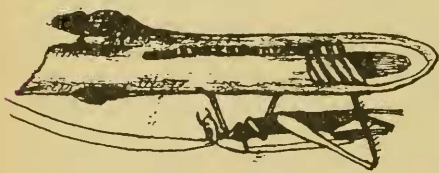
The winged beetles appear at about the time that raspberries and blackberries are in full bloom. They now mate, and soon afterwards deposit their eggs for another generation. These eggs are laid in or upon the young canes, and the young larvæ soon after produce other gouty-galls. The beetle is a slender and rather pretty insect. It is characterized by a brilliant coppery color upon head and thorax. Its body and hard wings are velvety black.

These borers infest both raspberries and blackberries, but rather prefer some of their numerous varieties.

The remedy is quite simple, because we understand the whole life history of this insect. The infested canes must be cut and burned before the beetles hatch. They must not be simply cut and left upon the ground, as is too often the case, because in doing so we protect the insect against the inclemencies of the winter, or otherwise assist it. The canes must be burned to make sure of the death of the enclosed larvæ. It is also quite important to treat all wild plants of such berries growing in the neighborhood, in the same way, as otherwise new supplies of beetles will constantly reach the cultivated plants. The beetles like to bask upon the leaves in the hottest sun of noon. By holding an inverted umbrella under the plant, and by striking the plant a sharp blow with a stick, large numbers can be collected and killed, as the insects drop upon the slightest provocation. By using an old umbrella the operation can be greatly simplified if it is kept soaking wet with kerosene oil, which, owing to its very penetrating qualities, kills all insects coming in contact with it.

This is a new remedy, never published before, but a very good one, as I found by many trials during the last two seasons. Not alone for this insect but for many others equally injurious to these and other plants. By having the inside of the umbrella lined with some porous material, which will retain the oil, it is greatly improved.

The eggs of another insect were also frequently found in canes received and observed in the fields. The life history of this insect, the Snowy Tree-cricket (*Ecanthus niveus*,) is illustrated upon the canvass before you. As the illustration (Fig. 3) shows, it is not the



(FIG. 3.)

insect itself that is injurious by eating the plants, or parts of them, but the habit of the female in using the canes for oviposition causes the damage, which is frequently very severe. The cane containing eggs is more or less

disfigured by a series of irregular and closely set punctures. If we open such a cane we find in the pith a large number of eggs. Each egg, pale yellowish in color, is a little curved affair, pointed at the lower, and capped at the upper end with regular granulations, only visible with the aid of a magnifying lens. Of course the presence of such eggs, crowded together as they are, causes the cane to die above the injured part. These eggs are laid late in the autumn, and cannot be discovered very readily at that time. But as the young crickets hatch rather late during the following spring, the place of oviposition is readily discovered by the diseased looks of the cane, and a pruning knife will soon remedy the evil. But the canes must be burned to prevent the hatching of the young insects. Although these latter themselves are rather beneficial, by feeding on leaf-lice, we must not allow them to increase, as other canes, for instance those of the grape-vine, and even tender twigs of fruit trees, are also seriously injured by them.

Another insect, the Buffalo Tree-hopper, is also illustrated upon the canvass. This is a comical looking triangular affair, trying to look like a ferocious buffalo, but lacking the size to inspire alarm.



Fig. 4.

This hopper (*Ceresa bubalus*) belongs to the order hemiptera, sub-order homoptera. In describing its personal appearance we might say: a very green looking object, mottled with brown dots, one-third of an inch long, very active and apt to jump away upon the slightest provocation. It is very shy, and if it knows that we observe it it will immediately hide behind a branch, or vanish by means of an extraordinary powerful jump. By looking at this creature the origin of its name, both of the scientific and popular, becomes self-evident. Yet this insect (and two others closely resembling it), small as it is, becomes sometimes very numerous, and injurious in proportion. Like all true bugs it absorbs the sap of plants by means of a rather long and sharp-pointed beak, thus injuring the plant. But the chief damage it causes is by laying its eggs in canes or twigs. They are punctured in a peculiar manner, as shown in the illustration. The young insects which hatch from these eggs are even more ridiculous looking things than their parents, as may be seen in the illustration and in the specimens before you in the box. As the insects themselves feed only by means of a beak, any application of arsenical poison is of no avail. The careful removal of their eggs and the use of an oiled umbrella is in most cases sufficient to keep them in check.

There are two other insects which often cause great injury to the canes of currants. Both are common in Minnesota and require strict vigilance to keep them under control. Both are illustrated by figures and specimens. They are cane-borers of the worst kind, though very dissimilar in general appearance.

The Imported Currant-borer (*Ægeria tipuli-formis*) is a very beautiful insect when quite fresh from the pupa. It is a moth, but does not greatly resemble such an insect, but looks more like a wasp or a long-legged fly. When flying, which is indulged in during the hottest parts of the day, this insect would not be taken for a moth at all. Still its beauty is but skin deep, as the ornamenting scales drop immediately when touched, and it is after all but one of the worst pests of the currant in a gaudy dress. The larva and pupa are shown also in the illustration. Both resemble very closely the

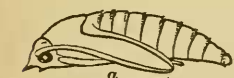


Fig. 5.



Fig. 6.

early stages of the peach-borer, an insect not found in any great numbers in this the Banana-belt of Minnesota. The larva, which is yellowish white, of a cylindrical shape, is distinguished by the possession of a dark-colored head and legs, and differs in this respect from the larva of our native current-borer, which lacks all traces of legs. When full grown, and before changing to a pupa, it eats

a hole or passage way nearly through the cane, leaving simply a thin film to hide it; this is very necessary as the delicate moth, lacking biting mouth-parts, would not be able to reach the light of day. The larva burrows in the centre of the cane, feeding all through the summer upon the pith. The tunnel thus made measures several inches in length.

The Native Currant-borer (*Psenocerus supernotatus*), is the larva of a rather fine-looking beetle, which has dark brown wing-cases ornamented with white spots, as seen in the illustration and specimens. (Fig. 7) It is not a very active insect, is seldom seen, and can only be obtained by beating the plant over an inverted umbrella. Its small, white, cylindrical and footless larva, with a brown head and black jaws, is also shown in the illustration, as well as the pupa. Many such borers are usually found in the same cane, where they feed upon the pith. The larva belongs to the round-



FIG. 7.

headed borers, whose injuries are frequently very great in apple orchards.

All these boring insects must be removed with the pruning knife, and be burned at once. This is a rather heroic treatment, and might well be modified, if the fruit-grower has the necessary time. He ought to consider that most, if not all of his insect enemies harbor parasites, which he cannot see. By burning cane and inhabitants he not alone kills his foes, but his friends as well. To protect the latter he should not burn the canes at once, but put them in fairly tight boxes, covered on top with a coarse screen. This would enable most of his friends, the parasites, to escape and to carry on the good work in garden and field, far better than any human being could do. Later the canes could be destroyed, and with them the enemies still in them or collected in the box, which they could not leave on account of their greater size. Of course in the case of the tree-cricket and buffalo-hopper this precaution would be of little avail, as the insects hatching from the eggs inside of the cane are too small to be made prisoners by a coarse screen. But if the boxes with infested canes were kept in the barn, away from any fresh food, these young insects would perish before reaching their food-plants; the parasites, on the contrary, being mostly furnished with wings, and needing little or no food, would soon find their way back to infested fields.

Looking at the box filled with insects injurious to his fruit the grower of these important plants will no doubt notice one thing: without labor no fruit can be grown successfully for a series of years.

O. L.